Greg Smith
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Changes in Version 3:

Incorporated suggested changes from Eric Senter
Incorporated numbers for program and other suggested changes from Iris Yamagata
Incorporated numbers for program from Gary Guacci

Added paragraph to introduction summarizing the findings.
Revised Figure 3 based on comments from Mike McGinnis.
Revised Tables 2, 3 and 4 because of changes to program costs.
Revised Objective 5. 1 to explain it better, and updated the average wells per basin for large basins.

Revised Summary table of costs.

June 8, 2009
Changes suggested by Carl Hauge

Strategic Plan for the Groundwater Level Monitoring Program

Version 3.1

Written in the Summer of 2008

Introduction

The Department's mission is to manage the water resources of California in cooperation with other agencies to benefit the State's people, and to protect, restore, and enhance the natural and human environments. In addition, the Department has a public trust responsibility and mission to protect and restore resources dependent on water. The authority includes the Department of Water Resources' Strategic Business Plan, and the California Water Plan, and California Water Code (Section 229 and 231).

Groundwater is a major water source in California. In normal years, groundwater is approximately 10% of total supply. In dry years, this can increase to 22% of total supply when groundwater may be the second largest source of water.[1] Basic, timely and accurate hydrologic data is required for sound policy and planning decisions.

Groundwater level data is collected by DWR's four district offices and Federal and local cooperators. The groundwater level measurements are managed and disseminated through the Water Data Library (http://wdl.water.ca.gov).

This strategic plan identifies and prioritizes 18 actions to improve the field collection, data management, and dissemination of groundwater level measurements. The Division of Planning and Local Assistance has no standard procedures for data collection, quality assurance or data exchange with financial assistance recipients. The number of wells DPLA itself monitors is increasing. The number of actively monitored wells by all cooperating agencies has decreased in the last 15 years. The number of cooperating agencies is decreasing, even with the coordination of financial assistance programs. And, Water Data Library has no groundwater level data for eleven areas of the State. If fully implemented these actions would cost $2,056,900 and take 47,808 hours.

History

DWR (or its predecessor) started measuring groundwater levels in 1917. Groundwater level monitoring was conducted on a local or regional scale in various areas of the state by DWR, federal, and/or local agencies. However, a systematic statewide program to monitor groundwater levels was not implemented until the 1950s(?). The data collected

[1] Numbers calculated from the California Water Plan, Update 2005. Volume 3. Table 1 – 3.

by these early programs was compiled, tabulated, disseminated manually. Data were published in a series of annual bulletins, beginning with Bulletin 39 in 1932, continuing with Bulletins 77 and 130 through the mid-1970s.

By 1971 development had begun on an electronic system for the storage, retrieval, publishing, and analyses of water related data using DWR computer equipment. The system, known as the Water Data Information System (WDIS), included surface water quantity, groundwater levels, surface water quality, groundwater quality, and precipitation data. This "data bank" contained records dating back to as early as 1900.

In 1985, DWR began work on an improved data management system. The transfer of groundwater levels from the legacy system began in 1987-88. Through the late 1980s and 1990s several unsuccessful attempts were made to modernize the WDIS system using various approaches and technologies. In 1999 the implementation of the data management system was modified to use web technologies, and was renamed “Water Data Library” (WDL). Appendix 1 contains a description of Water Data Library.

In 1992, DWR started collecting groundwater level measurements with electronic data loggers. Generally measurements were taken every hour or two. Over time, data logger measurements became more frequent. Measurements may be taken at any frequency or when the groundwater level drops by more than a pre-determined amount. (Measurements collected by data loggers are referred to as "continuous measurements," whereas measurements collected by hand are referred to as "periodic measurements.")

At the same time as data logger measurements were becoming more frequent, the parameters DWR could measure with more sophisticated equipment was increasing. Modern equipment can measure the barometric pressure, air temperature and water temperature, and land subsidence.

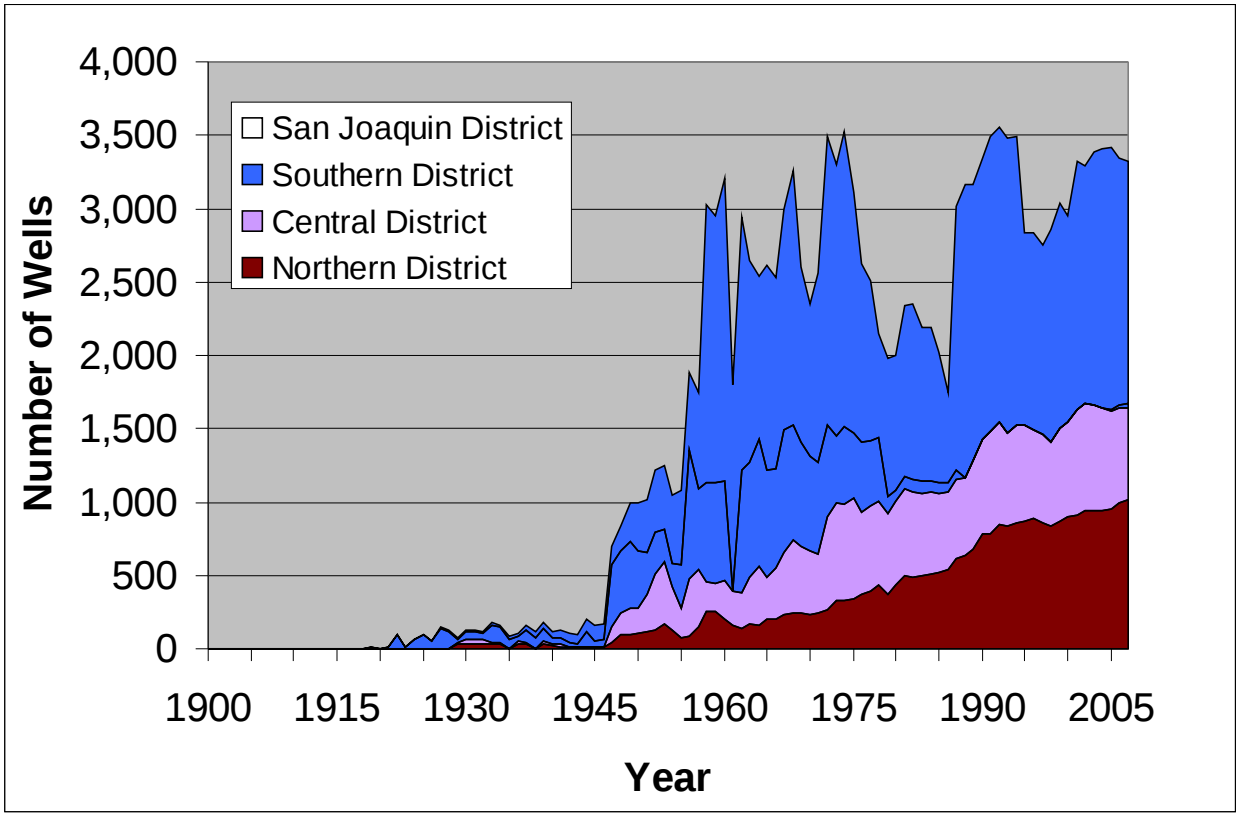
In 2002, groundwater levels became available to the public through Water Data Library. The data available was only periodic measurements, taken by DWR or one of its local or Federal cooperators.

In 2004, DWR purchased Hydstra, an off-the-shelf software to manageme and maintain time-series data. At the time of purchase, any time-series groundwater level data back to 1992 was imported into Hydstra.

In 2005, data from Hydstra became available on the Internet via the Water Data Library website.

The number of wells monitored by DWR each year since 1900 is presented in Figure 1. (Specific numbers are in Appendix 2.) The data from Figure 1 are taken from Water Data Library).

Figure 1. Wells Monitored by DWR



Though there the number of wells measured each year fluctuates, the overall trend is upward. Some simple statistics for the groundwater level monitoring program in each District are presented in Table 1. The slope and the adjusted R-squared are for linear regressions. San Joaquin District displays the greatest variability, and the poorest fit for a linear regression. Each of the programs is growing by 10 to 25 wells per year. Overall, the groundwater level monitoring program is growing by nearly 47 wells per year.

Table 1. Trends for the Groundwater Level Monitoring Program

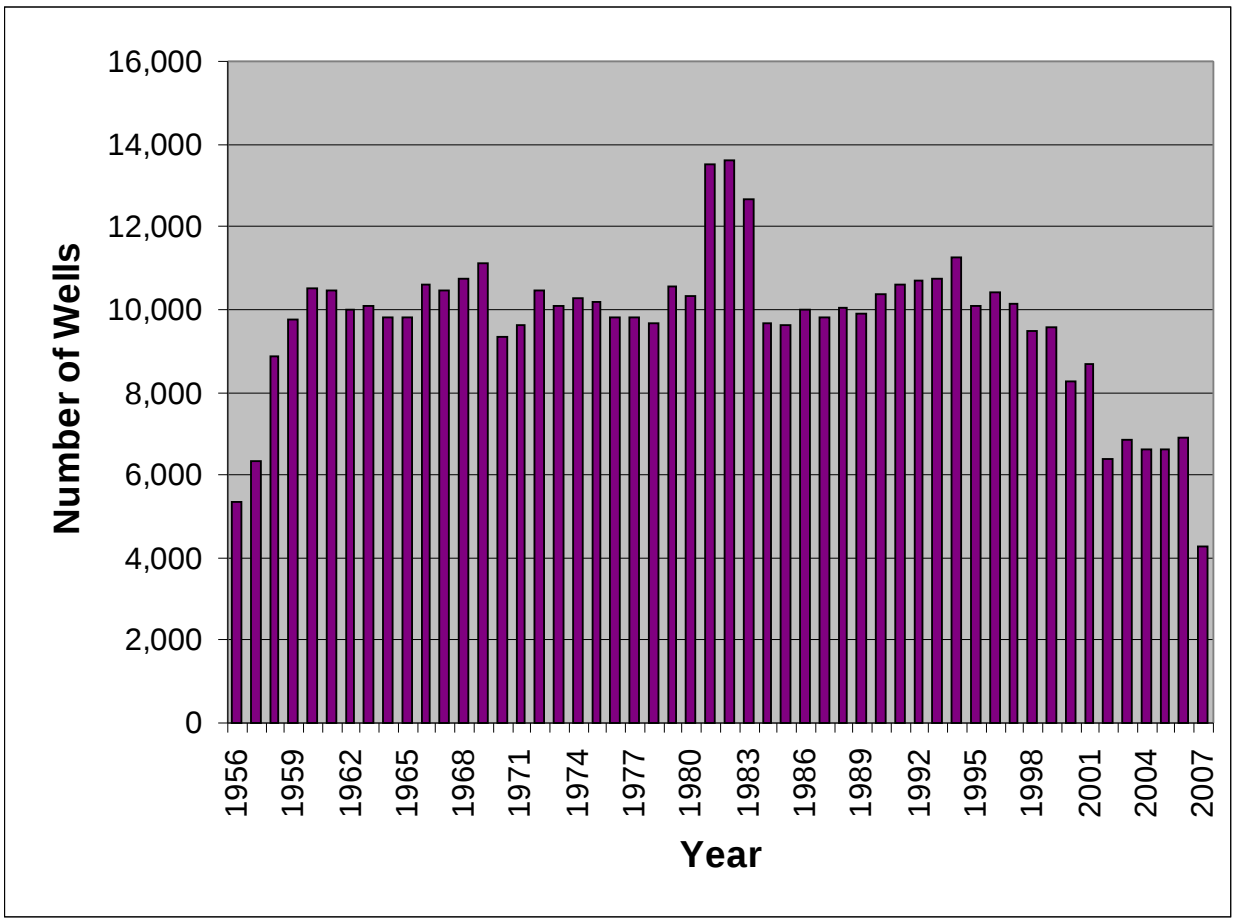
	San Joaquin District	Southern District	Central District	Northern District	Total
Slope	24.6		9.9	12.3	46.9
Adjusted R-Squared	70%		89%	88%	88%

If the program is growing by 47 wells per year, then the Program must find an additional $11,627[2] every year to cover the cost of monitoring these wells.

[2] This number comes from Table 4, the average annual cost per well, and Table 1, the number of new wells per year.

Figure 2 presents the total number of individual wells in Water Data Library monitored by any agency. In contrast to the growing number of wells DWR monitors each year, the number of wells in Water Data Library is declining in recent years. For many years, Water Data Library has 10,000 wells. Starting in the mid-1990's, the number of wells declined. In the early 2000's, the number of wells leveled off at approximately 6,500 wells per year.

Figure 2. Active Wells Each Year in Water Data Library



Program Costs

The hours and costs discussed in this document refer only to the field collection, quality checking, and data management of groundwater level data. The numbers do not include time or costs to analyze the groundwater data.

Table 2 presents the costs for the Groundwater Level Monitoring Program, including travel, vehicles, equipment and training. The total cost for the program is approximately $950,000 per year.

Table 2. Estimated Costs for the Groundwater Level Monitoring Program in Fiscal Year 2006-2007

Item	Central District	Northern District	San Joaquin District	Southern District	HQ	Annual Costs
Labor	$307,910	$119,580	$72,160	$19,988	$91,135	$610,773
Travel	$8,200	$8,200	$6,900	$2,700	$1,000	$27,000
Vehicle	$5,475	$6,470	$8,100	$1,375	$0	$21,420
Equipment	$74,220	$133,763	$5,171	$9,980	$22,000	$245,134
Training	$8,000	$10,500	$5,500	$6,750	$2,050	$32,800
Subtotal	$403,805	$278,512	$97,831	$40,793	$116,185	$937,127

Table 2 reveals differences between districts. Northern District collects continuous data in many wells, hence it spends more on equipment than other districts. San Joaquin District does not collect any continuous data, so has the least expenditures on equipment.

Table 3 presents the total number of annual visits to a well. There are different types of wells. Each district has its own schedule for maintenance and data collection. Visits to a well is a metric to compare costs regardless of the type of well and frequency of visits.

@@ this table is missing the continuous data collected by CD

Table 3. Annual Well Visits

	Central District	Northern District	San Joaquin District	Southern District	Annual Visits
Number of Periodic Well Visits	3,492	2,041	1,704	80	7,317
Number of Continuously Monitored Wells in Hydstra	7	796		40	843
Number of Special Study Well Visits	126	1,704			1,930
Number of Extensometer Well Visits	0	30			30
Subtotal	3,492	4,571	1,704	0	@@

Using numbers from Figure 1 and Table 2, Table 4 presents the average annual cost per well, and the average cost per visit per year. (To calculate the district costs in the previous table, the Headquarters program costs are prorated by the number of well visits.) The average annual cost is $251.20 per well. The annual cost ranges from $71.27 to $1,688.13 per well. The average annual cost per visit is $96.04. The annual cost ranges from $69.18 to over $351.69 per visit.

Table 4. Annual Average Costs

	Central District	Northern District	San Joaquin District	Southern District	Average
Average Annual Cost per Well	$639.50	$236.69	$71.27	$1,688.13	$247.92
Average Annual Cost per Visit	$127.46	$72.75	$69.18	$351.69	$94.78

These ranges of the average annual costs reflect the differences between each district. Each district has different procedures to collect, check and manage the data. As noted previously, the districts use technologies to different extents. Other differences include, but are not limited to, the frequency of monitoring wells; the amount of training done while monitoring, the amount of travel required to collect measurements, and how quickly data is entered into Water Data Library.

Table 5 presents the funding sources for the Groundwater Level Monitoring Program.

Table 5. Funding Sources

Funding Source	CD	ND	SJD	SD	HQ	Total
Water Environmental Monitoring	$280,000	$68,000	$100,000		$56,185	$404,185
Northern California Groundwater Basin Development		$117,000				$117,000
Northern California Sacramento Groundwater Basin Evaluation		$41,000				$41,000
SWP Future Water Supply - Phase 8	$100,000	$50,000			$60,000	$210,000
San Joaquin Valley Drainage			$50,000		$60,000	$110,000
Subtotal		$276,000			$116,185	$982,185

(Note: Southern District did not monitor groundwater levels in FY 2006 – 2007.)

Customers

The Division of Planning and Local Assistance (DPLA) and the Office of Water Use Efficiency and Transfers (OWUET) conducted a survey of its staff in the summer of 2007. The survey asked participants to identify what they did (functions) and who their customers were. Sometimes, more than one customer could be identified for a single function. Customers were then organized into six groups. The count of each customer

group for the Statewide Data Program[3] as a whole is presented in Table 6. The actual count is not as important as the relative count of the customer group.

Table 6. Customers for the Statewide Data Program

Customer Group	Count
Federal Agencies	116
Others, including consultants, lawyers, non-profit agencies, business groups and the public	98
DWR excluding DPLA and OWUET	69
Local Government Agencies	69
CA State Agencies excluding DWR	65
DPLA and OWUET	37

Most of the customers of the Statewide Data Program are outside of DPLA, the organization that collects the data. Therefore, DPLA needs to emphasize dissemination of its data as it does collection of its data.

Goals

The Groundwater Level Monitoring Program has four goals:

GWLM Goal 1	Monitor long-term change-in-storage trends in groundwater basins
GWLM Goal 2	Develop a complete State-wide groundwater level data set
GWLM Goal 3	Monitor interactions between groundwater and surface water
GWLM Goal 4	Assist local agencies with data collection and management of groundwater levels

These are long-term goals to support the two initiatives of the California Water Plan, implementing integrated regional water management and improving State-wide water management systems.

These goals can be separated into five different objectives:

GWLM Objective 1	Develop data standards for DWR
GWLM Objective 2	Correct existing data
GWLM Objective 3	Develop data exchanges with local cooperators
GWLM Objective 4	Fill-in data gaps
GWLM Objective 5	Develop products to promote the program

These objectives do not neatly correspond one-to-one with goals. For example, the goal of monitoring long-term change-in-storage tends of groundwater basins requires

[3] The Statewide Data Program includes programs for groundwater, well completion reporting, surface water, water quality, and some climate data.

DWR to fulfill objectives 1, 2, 3 and 4 (and possibly 6). As this example illustrates, each goal requires multiple objectives to be completed.

The objectives, in turn, can be divided into specific actions:

GWLM Objective 1.	**Data Standards For DWR**
GWLM Objective 1 Action 1	Document standard methods for collecting and qualifying groundwater level measurements
GWLM Objective 1 Action 2	Develop meta-data standards for groundwater level data and wells
GWLM Objective 1 Action 3	A standard policy on giving out well locations and water levels
GWLM Objective 1 Action 4	Coordinate Selection and Management of Equipment
GWLM Objective 1 Action 5	Develop business rules for data entry in Water Data Library
GWLM Objective 1 Action 6	Develop standards for adding a well to a grid
GWLM Objective 1 Action 7	Develop a standard set of use codes

GWLM Objective 2.	**Correct Existing Data**
GWLM Objective 2 Action 1	Qualify bad data in Hydstra
GWLM Objective 2 Action 2	Correct data discontinuities in Hydstra
GWLM Objective 2 Action 3	Correct quality discontinuities in Hydstra
GWLM Objective 2 Action 4	Correct spatial data for wells

GWLM Objective 3.	**Data Exchange Methodologies**
GWLM Objective 3 Action 1	Develop methodologies to exchange data with cooperators

GWLM Objective 4.	**Fill-In Data Gaps**
GWLM Objective 4 Action 1	Import historical data into Water Data Library
GWLM Objective 4 Action 2	Fill-In temporal data gaps in groundwater levels
GWLM Objective 4 Action 3	Fill-In spatial data gaps in groundwater levels

GWLM Objective 5.	**Products To Promote The Program**
GWLM Objective 5 Action 1	Qualify wells for each groundwater basin
GWLM Objective 5 Action 2	Prepare annual groundwater contour maps for Sacramento and San Joaquin Valleys
GWLM Objective 5 Action 3	Develop Reports from both Hydstra and Water Data Library

Under each objective, the actions are listed in order of importance. The next section is devoted to understanding the magnitude of each action, and the resources necessary to complete each action.

Groundwater Level Monitoring Objective 1 Action 1
Document Standard Methods for Collecting and Qualifying Groundwater Level Measurements

The Groundwater Level Monitoring Program lacks standards. The Division has no standards for:

1. Timing and coordination for collecting periodic groundwater level measurements
2. Frequency of collecting periodic groundwater level measurements. These would vary for standard grids and special projects.
3. Description of field methods for taking hand measurements
4. Checking and qualifying periodic groundwater level measurements

5. Frequency of collecting continuous groundwater level measurements
6. Calibrating data loggers
7. Checking and qualifying continuous groundwater level measurements (standard methods in Hydstra)
8. Standard form for field collection of continuous data
9. Transferring continuous data into Hydstra

10. Completing DWR forms for a new well
11. Standard codes for classifying well use
12. Method of locating a well (x, y and z coordinates)
13. Standard coordinates of well location (one or more of UTM, NAD83, NAD27, latitude and longitude)
14. Qualifying the location of a well (with a quality code)
15. Standards for discontinued wells in grids

In addition, DWR has does not track the equipment used to measure groundwater level.

Table 7 presents the hours estimated to complete this action. The estimated total cost to develop standards would be $43,300. This action must be done first, and is essential to completing other actions.

Table 7. Estimated Hours to Complete GWLM Objective 1 Action 1

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Periodic Measurements						
Draft Standards		24				24
Review Standards	16	16	16	16	16	80
Incorporate comments		16				16
Finalize Standards	8	8	8	8	8	40
Continuous Measurements						
Draft Standards		24				24
Review Standards	16	16	16		16	64
Incorporate comments		16				16
Finalize Standards	8	8	8		8	32
Well and Form Standards						
Draft Standards		24				24
Review Standards	16	16	16	16	16	80
Incorporate comments		16				16
Finalize Standards	8	8	8	8	8	40
Subtotal	72	192	72	48	72	456

Northern District would lead this effort, developing draft standards, incorporating comments, and “finalizing” the standards. These standards will have to be revised periodically. The costs of these revisions are not included in the previous table.

The metric by which to measure this action will be the publication of one to fifteen standards.

Groundwater Level Monitoring Objective 1 Action 2
Develop Meta-Data Standards for Groundwater Level Data and Wells

Meta-data is data about data; it describes a data set. Developing meta-data is an essential part of a data management program. Meta-data is especially important when working data sets from multiple cooperators. The meta-data can tell you if the data is comparable, and what the data is intended for.

DPLA does not have meta-data for its groundwater level data or wells. Groundwater level meta-data would include the frequency of measurement, explanation of quality

code, and references to standard procedures used for groundwater level measurement. With wells, DWR has a start with DWR Form 429. Unfortunately not everyone in each office uses this form, nor is the form used all the time. DPLA can use these standards as examples when helping local cooperators.

Table 8 presents the hours estimated to complete this action. This action would develop the meta-data for groundwater level measurements and wells. As part of this action, DPLA would coordinate with Well Completion Report, and in some cases include the State Well Number in the meta-data standards. DPLA Districts would also survey water utilities to see what meta-data standards they use. Some items from local water utilities may be included in the DPLA meta-data standards. The estimated total cost to develop meta-data standards would be $28,900.

Table 8. Estimated Hours to Complete GWLM Objective 1 Action 2

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Groundwater Level Meta-Data						
First Draft					4	4
First Review	6	6	6	6	6	30
Canvas Local Agencies	3	3	5	6		17
Second Draft					8	8
Second Review	5	5	5	5	5	25
Third Draft					8	8
Finalize	4	4	4	4	4	20
Wells						
First Draft					8	8
First Review	12	12	12	12	12	60
Canvas Local Agencies	6	6	9	12		33
Second Draft					8	8
Second Review	8	8	8	8	8	40
Third Draft					8	8
Finalize	8	8	8	8	8	40
Subtotal	52	52	57	61	87	309

This action would complement the development of standards and operating procedures.

This action would not include developing forms for meta-data standards that could be used to submit information to DWR. The development of meta-data forms is part of Groundwater Level Monitoring Objective 3 Action 1.

The metric by which to measure this action will be the publication of meta-data standards for groundwater level measurements and wells.

Groundwater Level Monitoring Objective 1 Action 3
A Standard Policy on Giving Out Well Locations and Water Levels

The location of a well is sensitive information. Many people have expressed the opinion that DWR should not publish the location of any well. This blanket statement articulates a fear and a desire to protect California's infrastructure. On the other hand, such a "one size fits all" statement rarely works. This blanket statement probably does not apply to monitoring wells; and does not acknowledge that well locations may already be in the public record. These are two examples of why are more nuanced policy needs to be developed by DWR.

DWR needs to develop a well reasoned policy on when to give out water level and well location information. The policy would have to flexible enough to cover the different types of wells and situations when locations are requested.

Table 9 presents the hours estimated to develop this policy. The estimated total cost to develop a standard security policy would be $15,400.

Table 9. Estimated Hours to Standard Security Policy

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Write Draft Proposal				16		16
Meeting to Review Draft	10	10	10	10	10	50
Edit Comments				8		8
Meeting to Draft Final Proposal	8	8	8	8	8	40
Meeting with Legal and DWR Management				8	8	16
Edit Comments				10		10
Meeting to Finalize Policy	4	4	4	4	4	20
Final Edit				2		2
Subtotal	22	22	22	66	30	162

The metric by which to measure this action will be the development of Department policy for locating wells.

Groundwater Level Monitoring Objective 1 Action 4
Coordinate Selection and Management of Equipment

DPLA uses five different types of equipment to measure periodic groundwater level measurements, three different types of probes to measure continuous groundwater level measurements, two different types of data loggers to store continuous groundwater level measurements, and two different types of GPS equipment to locate wells. The coordinating equipment selection and tracking equipment management are processes DPLA needs to implement to become more efficient.

Some districts have forms for tracking equipment. However, the forms do not cover all types of equipment, and the forms are different for each offices that uses them.

Hydstra has the ability to track equipment used to record continuous measurements; however, the Groundwater Monitoring Program does not use it for this purpose.. Hydstra can track the manufacturers and models of equipment used; frequency of repair and calibration and cost. Reports from Hydstra could be used for individual pieces of equipment, as well as statewide comparisons for models and manufacturers. If the Program were to do this, Southern District would need to purchase a computer for Hydstra, the Hydstra application, and a few site licenses.

This action would include:

1. Entering groundwater level monitoring equipment into Hydstra
2. Entering data loggers into Hydstra
3. Entering probes for continuous measurement
4. Entering GPS equipment into Hydstra
5. Developing reports across districts so equipment selection could be coordinated

Table 10 presents the hours estimated to complete this action. The estimated total cost to coordinate equipment would be $19,300.

Table 10. Estimated Hours to Complete GWLM Objective 1 Action 4

	Hours					
	CD	ND	SJD	SD	HQ	Total
Enter periodic measurement equipment into Hydstra	8	8	8	8		32
Enter data loggers into Hydstra	8	8		8		24
Enter probes into Hydstra	16	32		8		56
Enter GPS equipment into Hydstra	8	8	8	8		32
Develop draft reports					16	16
Review draft reports	8	8	8	8	8	40
Finalize reports					8	8
Subtotal	48	64	24	40	32	208

This cost does not include the cost to install Hydstra for the Southern District. The cost of doing so would be approximately $36,000 plus annual maintenance fees.

Coordinating equipment is not a one-time activity. The coordination will be an on-going activity. The continuing costs are not included in the previous table.

The metrics by which to measure this action will be:

- Each district entering equipment information into Hydstra
- Development of reports to track and compare equipment
- Continued use of Hydstra to track equipment use and history

Groundwater Level Monitoring Objective 1 Action 5
Develop Business Rules for Data Entry in Water Data Library

The groundwater level module for Water Data Library was developed in 2002, and was updated in 2006. Since then, ad hoc functionality has been added. Sometimes, this functionality does not enforce business rules and logic (standards currently used by DWR); in other cases, no standardized business logic has been developed (See Objective 1, Action 1).

This action would include identifying what web pages need additional rules and logic, time to program the changes, and updating the documentation for Water Data Library.

Table 11 presents the hours estimated to complete this action. The estimated total cost to codify business rules would be $7,100.

Table 11. Estimated Hours to Complete GWLM Objective 1 Action 5

	Hours					
	CD	ND	SJD	SD	HQ	Total
Meeting to Review Draft Rules	4	4	4	4	4	20
Program Rules					40	40
Update WDL documentation						20
Subtotal	4	4	4	4	64	80

DPLA should undertake this action after Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, and Groundwater Level Monitoring, Objective 1 Action 2, Meta-Data Standards.

The groundwater level module of Water Data Library needs to be re-written. This action is much less ambitious in its scope. It seeks to eliminate problems with the current programming, and do so as quickly and easily as possible.

The metric by which to measure this action will be the codifying business rules and logic in Water Data Library.

Groundwater Level Monitoring Objective 1 Action 6
Develop Standards for Adding a Well to a Grid

DPLA maintains monitoring grids for groundwater basins. Each grid includes a set of wells from which the basin conditions can be characterized. DPLA has not undertaken a systematic review of its grids. Before it can do this, DPLA needs to develop standards for adding a well to a monitoring grid. These standards would include:

- Required data about the well
- Required data about the basin
- Whether or not a well canvass is necessary
- Who is willing to let DWR measure groundwater levels (entry agreements with land owners)

Table 12 presents the hours estimated to complete this action. The estimated total cost to develop standards for adding a well to a monitoring grid would be $20,400.

Table 12. Estimated Hours to Complete GWLM Objective 1 Action 6

	Hours					
	CD	ND	SJD	SD	HQ	Total
Scope Standards	8	8	8	8	8	40
Compile Ideas					16	16
Meeting to Discuss Draft Standards	20	20	20	20	20	100
Edit standards					16	16
Review Final Draft	8	8	8	8	8	40
Final edits					8	8
Subtotal	36	36	36	36	76	220

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, Groundwater Level Monitoring, Objective 1 Action 2, Meta-Data Standards, and Groundwater Level Monitoring Objective 1 Action 5, Business Rules for Water Data Library.

The metric by which to measure this action will be the publication of standards for adding wells to a monitoring grid.

Groundwater Level Monitoring Objective 1 Action 7
Develop a Standard Set of Use Codes for Wells

The planned use codes for well completion reports are not the same as well use codes for groundwater monitoring. Table 13 compares the 24 well use codes from Water Data Library and the 20 planned used codes for well completion reports. The two lists need to be combined into a single, master list.

Table 13. Comparison of Use Codes

Well Use Codes in Water Data Library	Planned Uses for Well Completion Reports
Fire or Frost Protection	None
Fire or Frost Protection & Dom	Water Supply - Domestic
Domestic	Water Supply -Industrial
Domestic & Industrial	Water Supply - Irrigation
Domestic & Stock	Water Supply - Public
Irrigation	Cathodic Protection
Irrigation & Domestic	Destruction
Irrigation & Observation	Dewatering
Irrigation & Stock	Heat Exchange
Industrial	Injection
Industrial & Stock	Monitoring
Observation	Remediation
Public Supply	Sparging
Public Supply & Domestic	Test Well
Recreation	Vapor Extraction
Stock	Stock Watering
Test	Agriculture
Unused	Injection/Extraction
Unused Domestic	Piezometer
Unused Irrigation	Commercial
Unused Stock	
Extraction or Injection	
Destroyed	
Undetermined	

Once a master list has been created, the changes have to be incorporated into groundwater level measurements in Water Data Library, and into the Well Completion Report data set. Queries, forms and reports for these data sets will have to be changed to use the master list.

Table 14 presents the hours estimated to complete this action. The estimated total cost to develop standard use codes would be $6,800.

Table 14. Estimated Hours to Complete GWLM Objective 1 Action 7

	Hours					
	CD	ND	SJD	SD	HQ	Total
Develop Master List					2	2
Review List, and Process to Make Changes	6	6	6	6	6	30
Modify codes in WDL		10			30	40
Work with well completion report data model					2	2
Subtotal	6	16	6	6	40	74

The metrics by which to measure this action will be:

- ❖ The publication of a single set of use codes for wells
- ❖ The implementation of the set of use codes in Water Data Library

Groundwater Level Monitoring Objective 2 Action 1
Qualify Bad Data in Hydstra

Hydstra has several tools to test data. One of the tests checks the percentage of poor quality data in a single time series for a site. Each continuously monitored groundwater depth is a single time series. To pass the test, a time series must have less than 5% of the data qualified a poor quality. If 5% or more of the data is poor quality, then the time series fails the test. Table 15 presents results of this test in early October 2007. 27% of the 227 of the Depth to Groundwater time series failed this test. A site may have failed because equipment failed and therefore there is no data. Or a site may have failed because the data was not checked and qualified.

Table 15. Hydstra Test for Bad Depth to Groundwater Time Series

	Test for Bad Quality Depth to Groundwater Time Series
Number of Continuously Monitored Wells	227
Number of Wells Passing Test	166
Percent of Wells Passing	73%
Number of Wells Failing Test	61
Percent of Wells Failing	27%

Table 16 presents the hours estimated to complete this action. The number of wells in each District is presented in the first row. Subsequent rows in the table present the hours estimated to correct one well. The subtotal row presents the total estimated hours for all wells in the District. The estimated total cost to develop correct bad data in Hydstra would be $26,100.

Table 16. Estimated Hours to Complete GWLM Objective 2 Action 1

	Hours					
	CD	ND	SJD	SD	HQ	Total
Number of Wells	13	57				
For each well						
Correct data in Hydstra	3	3				210
Regenerate reports					1	70
Subtotal	39	171			70	280

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards.

The metric by which to measure this action will be the correction of quality codes in Hydstra for sites in each district.

Groundwater Level Monitoring Objective 2 Action 2
Correct Data Discontinuities in Hydstra

One of the tests Hydstra has is to check for data discontinuities. Hydstra stores time series data in blocks. A discontinuity occurs when the end of one block of data does not match up with the beginning of the next block of data. A site fails the test when there are one or more data discontinuities for the time series. Table 17 presents results of this test in early October 2007. 13% of the 227 of the Depth to Groundwater time series failed this test. A site may have failed because equipment failed and therefore there is no data. Or a site may have failed because the data was not checked and qualified.

Table 17. Hydstra Tests for Discontinuities of Groundwater Time Series

	Test for Data Discontinuities	Test for Quality Discontinuities
Number of Continuously Monitored Wells	227	227
Number of Wells Passing Test	198	213
Percent of Wells Passing	87%	94%
Number of Wells Failing Test	29	14
Percent of Wells Failing	13%	6%

Table 18 presents the hours estimated to complete this action. The number of wells in each District is presented in the first row. Subsequent rows in the table present the hours estimated to correct one well. The subtotal row presents the total estimated hours for all wells in the District. For Headquarters, the hours are multiplied by the total

number of wells in all districts. The estimated total cost to correct data discontinuities would be $17,200.

Table 18. Estimated Hours to Complete GWLM Objective 2 Action 2

	Hours					
	CD	ND	SJD	SD	HQ	Total
Number of Wells	8	38				
For each well						
Correct data in Hydstra	3	3				138
Regenerate reports					1	46
Subtotal	24	114			46	184

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards.

The metric by which to measure this action will be the correction of data discontinuities in Hydstra for sites in each district.

Groundwater Level Monitoring Objective 2 Action 3
Correct Quality Discontinuities in Hydstra

A test similar to the one discussed in the previous action is a test for data quality continuity. The quality of data at the end of one block should match the quality of data at the beginning of the next block. A site fails the test when there are one or more data quality discontinuities for the time series. Table 13 presents results of this test in early October 2007. 6% of the 227 of the Depth to Groundwater time series failed this test. A site may have failed because equipment failed and therefore there data quality changes. Or a site may have failed because the data quality was not checked

Table 19 presents the hours estimated to complete this action. The number of wells in each District is presented in the first row. Subsequent rows in the table present the hours estimated to correct one well. The subtotal row presents the total estimated hours for all wells in the District. For Headquarters, the hours are multiplied by the total number of wells in all districts. The estimated total cost to correct quality discontinuities would be $6,900.

Table 19. Estimated Hours to Complete GWLM Objective 2 Action 3

	Hours					
	CD	ND	SJD	SD	HQ	Total
Number of Wells	6	13				
For each well						
Correct data in Hydstra	3	3				57
Regenerate reports					1	19
Subtotal	18	39			19	76

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards.

The metric by which to measure this action will be the correction of quality discontinuities in Hydstra for sites in each district.

Groundwater Level Monitoring Objective 2 Action 4
Collect Spatial Data for Wells

Water Data Library has 42,917 individual wells. Three datums for spatial coordinate systems are used: NAD27, NAD83 and WGS84. For each datum, spatial data can use a projection of Latitude and Longitude, UTM or State Plane.

Table 20 presents the number of wells with spatial data in Water Data Library. All wells in Water Data Library use some combination of the coordinate system and project. Most of the wells use the NAD27 coordinate system. Few wells have spatial data in the NAD83 coordinate system.

Table 20. Spatial Information in Water Data Library

	NAD27	NAD83
Latitude and Longitude	42,716	4,463
Universal Transverse Mercator	42,766	4,473
State Plane	130	

In addition to Water Data Library, Hydstra has spatial data. Hydstra adds a third datum, WGS84. Sites in Hydstra are classified by type, groundwater and surface water. And, some sites in Hydstra do not have any spatial information at all. Table 21 presents a summary of the spatial information in Hydstra.

Table 21. Spatial Information in Hydstra

	NAD27	NAD83	WGS84	No Information
Latitude and Longitude				
Groundwater	2	65	14	262
Surface Water	195	16	10	137
Universal Transverse Mercator				
Groundwater	7	234		69
Surface Water	60	96		230
State Plane				
Groundwater	24			
Surface Water				

The de facto datum for data in Water Data Library is NAD27. The official datum for California is NAD83[4] (horizontal) and NAV88[5] (vertical). Once spatial information is in one data and projection, it is relatively easy to translate the coordinates to another data and projection.

Two steps are necessary to complete this action:

- Getting spatial information for sites that do not have any and enter it into Water Data Library
- Translating spatial information into NAD83 (and NAV88) datum and one of the projections (Latitude and Longitude or Universal Transverse Mercator)

In this action, the projection of State Plane would be dropped.

Table 22 presents the hours estimated to complete this action. The estimated total cost to complete spatial information would be $22,600.

Table 22. Estimated Hours to Complete GWLM Objective 2 Action 4

	Hours					
	CD	ND	SJD	SD	HQ	Total
Collect spatial data	20	110				130
Translate spatial data					80	80
Load information back into Hydstra	5	28				33
Subtotal	25	138			80	243

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, Groundwater Level Monitoring Objective 1 Action 2, Developing Meta-Data Standards, and Groundwater Level Monitoring Objective 1 Action 6, Developing Standards for Adding a Well to a Grid.

[4] California Public Resource Code, Section 8852.
[5] California Public Resource Code, Section 8853.

Groundwater Level Monitoring Objective 3 Action 1
Develop Data Exchange Methodologies

Efficient data exchange with local cooperators has been a goal for DPLA for a long while. This goal has been elusive since before the awards of Proposition 13 and Proposition 50 grants.

This action has two specific tasks:

1. Develop one (or a few) data templates
2. Develop one (or a few) meta-data templates

Both templates would be in Excel. Local cooperators could use them to identify and complete required information for groundwater level measurements. When completed, DPLA could use these templates to enter information into Water Data Library. The process to import data from these templates into Water Data Library would be automated as much as possible.

Table 23 presents the hours estimated to complete develop data exchange methodologies. The estimated total cost to develop data exchange methodologies would be $31,400.

Table 23. Estimated Hours to Develop Data Exchange Methodologies

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Draft Data Reporting Templates	16	16	16	16	16	80
Develop Data Reporting Templates					40	40
Finalize Data Reporting Templates	10	10	10	10	10	50
Draft Metadata Templates	16	16	16	16	16	80
Develop Metadata Templates					40	40
Finalize Metadata Templates	10	10	10	10	10	50
Subtotal	52	52	52	52	132	340

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, Groundwater Level Monitoring Objective 1 Action 2, Develop Meta-Data Standards, and Groundwater Level Monitoring Objective 1 Action 6, Developing Standards for Adding a Well to a Grid. These actions will be necessary to developing the proposed templates.

In addition to the one-time costs of developing the data exchange systems, there will be continuing costs. Our experience tells us that, even with templates, DPLA will have to work with agencies to make the data exchange successful. This assistance will include

training, answering questions, feedback to agencies about issues to correct, and working to correct mistakes.

Sophisticated cooperators may not be inclined to use the templates. Other data exchange methodologies will have to be developed for local cooperators that already have their own data management systems.

Outreach and the continuing costs of data exchange are not included as part of this action. Those costs would depend on the number of cooperators and the technical sophistication of the cooperators. Nor are costs to develop automated exchanges with more sophisticated agencies part of this action.

The metric by which to measure this action will be the publication of data and meta-data template.

Groundwater Level Monitoring Objective 4 Action 1
Import Historical Cooperator's Data into Water Data Library

DPLA has groundwater level measurements, either in old paper reports or in electronic form that are not in Water Data Library. Adding this data to Water Data Library would be one of the easier steps DPLA could take to make the groundwater level data set more comprehensive.

This action is distinguished from Objective 4 Action 2 in that DPLA has this data; whereas in Objective 4 Action 2, DPLA does not have the data, and would have to solicit it from local cooperators.

This action would enter historical groundwater level measurements that DWR has into Water Data Library. Most of this information is from Southern District, though there is some historical Central District data that is ready to be imported. Historic data from other districts is already in Water Data Library.

@@ Check with SJD to make sure their historical data is in Water Data Library

Table 24 presents the hours estimated to complete this action. The estimated total cost to import historical data into Water Data Library would be $176,000.

Table 24. Estimated Hours to Complete GWLM Objective 4 Action 1

	Hours					
	CD	ND	SJD	SD	HQ	Total
Identify what historical data is missing				10		10
Key Enter and Standardize Data				1,500		1,500
Load data into WDL					200	200
Review data				80		80

Subtotal	1,590	200	1,790

The metric by which to measure this action will be the entry of historic data into Water Data Library.

Groundwater Level Monitoring Objective 4 Action 2
Fill-In Temporal Data Gaps in Groundwater Levels

Almost as long as DWR has been monitoring wells, DWR has been cooperating with local water utilities to monitoring groundwater levels. This action would get groundwater level measurements from 36 cooperators that have missing data.

This action is distinguished from Objective 4 Action 1 in that DPLA does not have this data, whereas in Objective 4 Action 1, DPLA has the data, but it is not in Water Data Library.

Figure 3 presents a summary of the temporal distribution of wells in Water Data Library since 1956. The black line in Figure 3 represents the cumulative number of agencies that reported, or should have reported, groundwater level measurement from 1956 until 2007. Not all the agencies report groundwater level measurements every year. Some agencies miss reporting a year or two. Other agencies report only a portion of all the wells they monitor. The blue line represents agencies that reported groundwater level measurements for at least one well during the year. For each agency, an average number of wells per year was calculated for the 51-year period. The red line represents the number of agencies reporting groundwater level measurements for their average number of well or greater.

The number of agencies that should report groundwater level measurements has grown over the years to 66. The number of agencies reporting any measurements in a give year has averaged about 37. There was a spike in the late 1970s, and a corresponding drop in the 1980s. Over the last three yeas, this has dropped slightly, to 33 agencies. The number of agencies reporting measurements for most of their wells peaked in 1979, at 49. Since then, this number has declined. Today, only 13 or so agencies report measurements for most of their wells.

Figure 3. Temporal Distribution of Groundwater Level Reporting

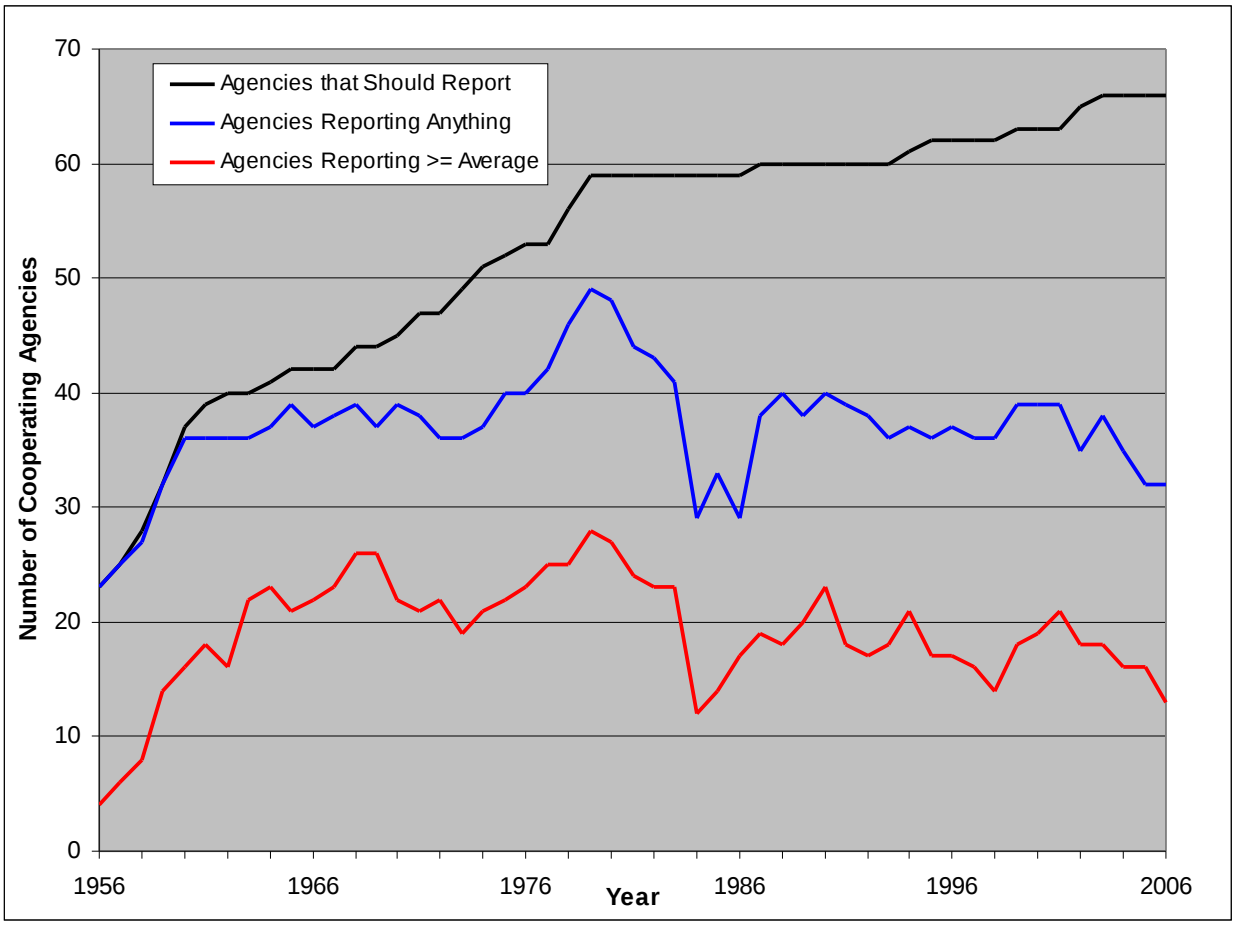
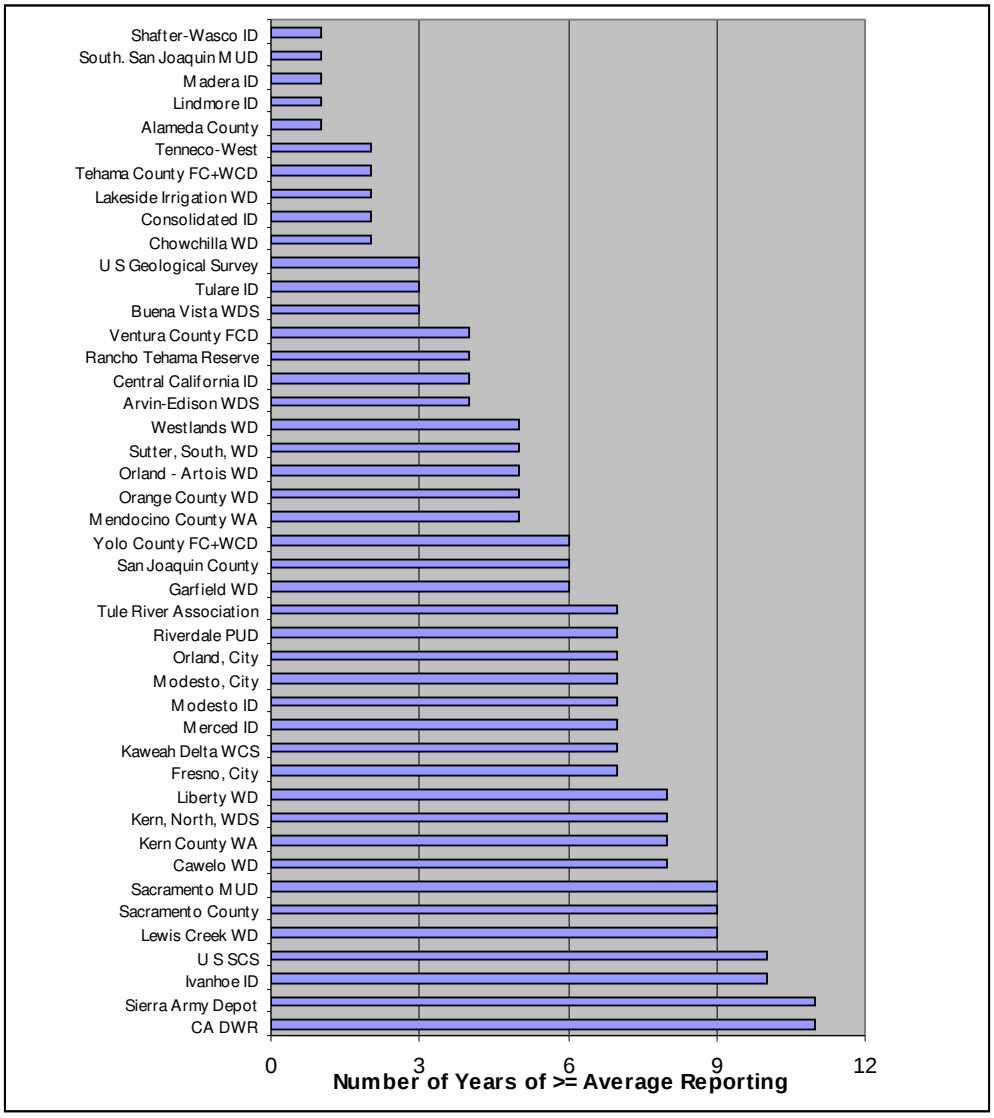


Figure 4 deconstructs the red line in Figure 3 between 1996 and 2006, and show how problematic groundwater level reporting to DWR can be. 31 different cooperators reported their average number of wells or greater at least once during the eleven years. Only two agencies, DWR and Sierra Army Depot, reported in all eleven years. Four agencies only reported in one of the eleven years. On average the 31 agencies that submitted anything, reported most of measurements for most of their in only 6 of the eleven years (54% of the time).

Figure 4. Comparative Reporting of Cooperators with Better than Average Reporting from 1996 - 2006



There are many reasons why agencies do not report every year. Staff at cooperating agencies change. With the change comes the need to re-establish DWR's relationship with the agency. Establishing a strong relationship with an agency takes years. Agencies also have experienced many of the same pressures DWR has; funding cuts and staff asked to do more with less. And, DWR personnel no longer has the time to call cooperating agencies if they have not submitted measurements.

This action would fill in data from missing years for 43 cooperators in Figure 4. These cooperators have contributed some groundwater level measurements to Water Data Library since 1995 and have missing years of missing data during the same period. On Figure 3, this action would raise the red line towards the blue line.

Table 25 presents the hours estimated to complete this action. The first row presents the number of cooperators in each district. Subsequent rows in the table present the hours estimated to developing a working relationship with each agency, and import their data in Water Data Library. The subtotal row presents the total estimated hours for all cooperators in a District. For Headquarters, the hours are multiplied by the total number of cooperators in all districts. The estimated total cost to fill-in the temporal gaps of the last eleven years would be $146,000.

Table 25. Estimated Hours to Complete GWLM Objective 4 Action 2

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Number of cooperators	7	5	28	3		
For each cooperator						
First meeting	10	10	10	10		430
Second meeting	8	8	8	8		344
Third meeting	6	6	6	6		258
Load Data into WDL					2	86
Review and comments on data exchange	8	8	8	8		344
Subtotal for all cooperators	224	160	896	96	86	1,462

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, and Groundwater Level Monitoring Objective 1 Action 2, Meta-Data Standards

The metric by which to measure this action will be the entry of historic data from local cooperators into Water Data Library.

Groundwater Level Monitoring Objective 4 Action 3
Fill-In Spatial Data Gaps in Groundwater Levels

In addition to temporal data gaps, Water Data Library has spatial data gaps. There are regions of the State for which Water Data Library does not have groundwater level data. These regions can be divided into those where we know agencies are collecting groundwater level measurements and those where we do not know if agencies are collecting groundwater level measurements.

Water Data Library is lacking groundwater level measurements for

- Alameda County Water District (Niles Cone)
- Alameda County Zone 7 (Livermore)
- Alameda County Public Works (East Bay Plain)

- Los Angeles County
- Monterey County Water Resources Agency (Salinas Valley)
- Pajaro Valley Water Management Agency
- San Benito County
- San Luis Obispo County
- Santa Clara Valley Water District (Santa Clara Valley)
- Santa Cruz County
- Tehachapi-Cummins County Water District

This action would collect groundwater level measurements from these agencies.

Table 26 presents the hours estimated to identify new cooperators, establish relationships with them, and put their data into Water Data Library. The number of cooperators in each District is presented in the first row. Subsequent rows in the table present the hours estimated to developing a working relationship with each agency, and import their data in Water Data Library. The subtotal row presents the total estimated hours for all cooperators in a District. For Headquarters, the hours are multiplied by the total number of cooperators in all districts. The estimated total cost to fill-in in known spatial data gaps would be $55,000.

Table 26. Estimated Hours to Collect Missing Spatial Data

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Number of cooperators	4		5	2		
For each cooperator						
First meeting	16		16	16		160
Second meeting	12		12	12		120
Third meeting	10		10	10		100
Load Data into WDL					8	80
Review and comments on data exchange	8		8	8		80
Subtotal for all cooperators	184		230	92	88	594

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, and Groundwater Level Monitoring Objective 1 Action 2, Meta-Data Standards

In addition to the one-time costs of creating a more comprehensive spatial data set, DPLA will have to maintain relationships with those agencies. The continuing costs will depend on the technical sophistication of the cooperating agency. Continuing costs are not included as part of this action.

The metric by which to measure this action will be the entry of data from these ten local cooperators into Water Data Library.

Groundwater Level Monitoring Objective 5 Action 1
Qualify Wells for Each Groundwater Basin

One of the goals of the program is to monitor the long term trends in the change in storage of basins. To do this, DPLA needs to review the wells used for these analyses for each basin. Water Data Library has 477 basins in California, so the scope of this action is potentially very large. Appendix 3 contains a list of all the groundwater basins in Water Data Library that have any wells, the number of wells in each basin, and the number of groundwater basins with wells in each district.

This action will qualify wells[6] in only a third of the basins in Northern, Central and San Joaquin Districts; and a fourth of the basins in Southern District.[7] Qualifying wells in basins was limited because there are many basins with only a few wells. Qualifying wells in one third of the basins would limit the action to basins that have 29 or more wells in Central District.; that have 23 or more wells in Northern District; that have 530 well ore more in San Joaquin District, and that have 69 or more wells in Southern District.

Table 27 presents the hours estimated to complete this action. The first row of the table presents the number of basins to quality in each district. The second row of the table presents the average number of wells per basin in the district. These numbers are calculated from the table in Appendix 3. The estimated total cost to qualify wells for roughly one-third of the basins in California would be $1,300,000.

[6] Select wells that have good construction information and have a reasonable period of record.

[7] The methodology selects the basins with the most wells from Appendix 3 in each district until one third (or one fourth) of the basins have been selected. These basins are referred to as "large basins" because of the large number of well, and regardless of spatial extent.

Table 27. Estimated Hours to Qualify Wells for Some Groundwater Basins

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Number of Large Basins	12	14	10	49		
Average Number of Wells per Large Basin[8]	203	120	1,372	419		
Prioritize Basins	2	2	2	8		14
Select wells to use to future analyses	625	428	3,316	5,129		9,498
Finalize wells and basin information	49	57	39	196		341
Group in WDL	200	137	1,061	1,641		3,040
Subtotal	876	625	4,418	6,974		12,893

From our experience, it will take about an hour per well to find a well completion report, match screened intervals for wells in the basins, and select wells for analyses based on use, length of record, access and other factors. On the other hand, many wells can be eliminated because we do not have well completion reports or the period of record is too short. On average, it will take about 15 minutes per well. It will also take four hours per basin to finalize all the wells and their spatial distribution. Finally, it will take about 10 minutes per well to group in Water Data Library for future use.

DPLA should undertake this action only after completing Groundwater Level Monitoring Objective 1 Action 1, Developing Standards, Groundwater Level Monitoring Objective 1 Action 2, Meta-Data Standards, and Groundwater Level Monitoring Objective 1 Action 6, Standards For Adding A Well To A Grid.

The metric by which to measure this action will be the number of basins for which wells are qualified and grouped in Water Data Library.

When this action is complete, DPLA will be able to recommend areas that need additional monitoring, or to use different wells to monitor the groundwater levels.

Groundwater Level Monitoring Objective 5 Action 2
Prepare Annual Groundwater Contour Maps for Sacramento and San Joaquin Valleys

[8] This average is limited to the basins with the most wells in each district. The statistics for all the basins in each district are:

CDNDSJDSDAverage number of wells in a basin7245533117Standard Deviation of the number of wells in a basin13976797299Minimum number of wells in a basin1131Maximum number of wells in a basin6203053,0682,309

This action only addresses groundwater contour maps in two groundwater basins, not all of the groundwater basins in California. It is an action that cannot be fully automated. Draft maps have to be prepared and coordinated. Edits have to be done by hand. Finally, maps have to be printed and distributed.

Table 28 presents the hours estimated to complete this action. The estimated total cost to prepare annual groundwater contour maps for the Sacramento and San Joaquin Valleys would be $28,000.

Table 28. Estimated Hours to Prepare Groundwater Contour Maps for Sacramento and San Joaquin Valleys

	Hours					
	CD	**ND**	**SJD**	**SD**	**HQ**	**Total**
Draft maps	32	32	32			96
Meeting to discuss plots	6	6	6	6	6	30
Review and compare to previous year	24	24	24			72
Print and distribute maps						
Subtotal for initial set up	62	62	62	6	6	198

This action would best be done after completing Groundwater Level Monitoring Objective 5 Action 1.

The metric by which to measure this action will be the number of basins for which wells are qualified and grouped in Water Data Library.

Groundwater Level Monitoring Objective 5 Action 3
Develop Reports from both Hydstra and Water Data Library

Groundwater levels are stored in both Water Data Library and Hydstra. These two data management systems are separate. This action would develop unified reports that use data from both Water Data Library and Hydstra.

Table 29 presents the hours estimated to develop unified groundwater reports from Water Data Library and Hydstra. The estimated total cost to develop reports from both Water Data Library and Hydstra would be $20,000.

Table 29. Estimated Hours to Develop Unified Groundwater Reports

	Hours					
	CD	ND	SJD	SD	HQ	Total
Write code to pull generalized data from Hydstra					80	80
Write code to compile data from both Hydstra and WDL and produce tabular data					40	40
Write code to produce a plot					60	60
Review products	6	6	6	6	6	30
Final Edits					20	20
Subtotal	6	6	6	6	206	230

The metric by which to measure this action will be the publication of groundwater level reports that include data from both Water Data Library and Hydstra.

Summary

DWR's historic groundwater data is invaluable. The data is used to evaluate financial assistance proposals, for groundwater transfers and conjunctive water management, for water quality studies, for specific regional studies, and to plan for the future.

For our customers, both inside and outside of the Department, the trends are disturbing.

- The cost of the program is approximately $950,000 in FY 2006-2007. (Unfortunately, there are no numbers to show the funding over time. The anecdotal evidence suggests the program has been cut over the years.)
- Funding for the program is fragmented among 5 difference sources, many of which are year to year.
- The number of wells DPLA is monitoring is increasing (Figure 1).
- The number of active wells each year is decreasing (Figure 2).
- The number of actively participating cooperators has been declining since the 1980s. (Figure 3 – red line).
- In last eleven years, the 31 most active cooperators have, on average, only managed to submit most of their groundwater level measurements 54% of the time.
- The Division of Planning and Local Assistance has no standard procedures for data collection, quality assurance or data exchange with financial assistance recipients.
- There are eleven areas of the State for which Water Data Library has no groundwater level measurements.

The Groundwater Level Monitoring Program has identified and prioritized eighteen actions necessary to improve the field collection, data management, and dissemination

Table 29. Summary of Costs for Actions

	Objective	Action	Dollars					
			CD	ND	SJD	SD	HQ	Total
1	1.1	Standard Methods	$5,400	$19,100	$7,700	$4,800	$6,300	$43,300
2	1.2	Meta-Data Standards	$3,900	$5,200	$6,100	$6,100	$7,600	$28,900
3	1.3	A Standard Policy On Well Locations	$1,700	$2,200	$2,300	$6,600	$2,600	$15,400
4	1.4	Coordinate Equipment	$3,600	$6,400	$2,600	$4,000	$2,800	$19,300
5	1.5	Develop Business Rules	$300	$400	$400	$400	$5,600	$7,100
6	1.6	Standards For Adding A Well To A Grid	$2,700	$3,600	$3,800	$3,600	$6,700	$20,400
7	1.7	Develop A Standard Set Of Use Codes	$500	$1,600	$600	$600	$3,500	$6,800
		Subtotal	*$18,100*	*$38,500*	*$23,500*	*$26,100*	*$35,100*	*$141,200*
8	2.1	Qualify Bad Data In Hydstra	$2,900	$17,000			$6,100	$26,100
9	2.2	Correct Data Discontinuities In Hydstra	$1,800	$11,400			$4,000	$17,200
10	2.3	Correct Quality Discontinuities In Hydstra	$1,400	$3,900			$1,700	$6,900
11	2.4	Collect Spatial Data For Wells	$1,900	$13,700			$7,000	$22,600
		Subtotal	*$8,000*	*$84,500*	*$23,500*	*$26,100*	*$53,900*	*$214,000*
12	3.1	Develop Data Exchange Methodologies	$3,900	$5,200	$5,500	$5,200	$11,600	$31,400
13	4.1	Import Historical Cooperator's Data				$158,900	$17,500	$176,400
14	4.2	Fill In Temporal Data Gaps	$16,800	$15,900	$44,400	$9,600	$4,900	$91,700
15	4.3	Fill In Spatial Data Gaps	$13,800		$24,500	$9,200	$7,700	$55,300
		Subtotal	*$30,600*	*$15,900*	*$68,900*	*$177,700*	*$30,100*	*$323,400*
16	5.1	Qualify Wells For Each Basin	$65,800	$62,300	$471,500	$697,000		$1,296,500
1	5.2	Prepare Groundwater Contour Maps	$7,700	$9,200	$12,200	$600	$500	$30,100

17								
18	5.3	Reports From Both Hydstra And WDL	$500	$600	$600	$600	$18,100	$20,300
		Subtotal	*$74,000*	*$72,100*	*$484,300*	*$698,200*	*$18,600*	*$1,346,900*
	Total		**$134,600**	**$216,200**	**$605,700**	**$933,300**	**$149,300**	**$2,056,900**

of groundwater data. These are actions that are not being done now, or are being done very slowly. Collectively, the actions are estimated to cost $2,056,900 (Table 30) and take 47,808 hours.

To reverse the trends and support the groundwater level monitoring program, the Department will have to make some strategic investments strengthen the groundwater level monitoring program. Our priority is to complete the first thirteen actions in the order they are listed. Objective 1 Action 1 is the highest priority, and should be done first; next would come Objective 1 Action 2, and so on until Objective 4 Action 1. As noted in the description for each action, they are not independent. Some actions must be completed before others can be started. These thirteen actions would cost approximately $421,800, and take an estimated 4,422 hours (about 2.5 PYs).

These thirteen actions cannot be addressed in a timely manner without additional resources. These actions do not include continuing costs, or costs to analyze groundwater data for specific programs.

These thirteen actions cannot be contracted out. These actions require intimate knowledge of the data, cooperation between districts, and decisions that will impact the program for years. If DWR expects DPLA to own and stand behind the groundwater data, these actions must be completed by DPLA.

Historical groundwater levels are essential (though not the only information necessary) to evaluating change in storage of groundwater basins. Daily and seasonal groundwater levels are fundamental to understanding interactions between groundwater and surface water. This information used with analytical tools in many programs in DPLA, the Department, and in State agencies.

The California Water Plan needs groundwater level information to estimate storage, and change in storage, of groundwater supplies. Financial assistance programs (Proposition 84, 50, 13 and others) requires groundwater level information to evaluate integrated regional water management, conjunctive water management, and infrastructure proposals.

Historic groundwater levels are required to calibrate supply models used by the Department (CALSIM), the USGS, private consultants and others. This information is also important to model water quality, and potential impacts on water quality.

Only with a strong program will the Department be able to help regional groups and local agencies establish their own groundwater level field programs and establish successful data exchange methodologies with local cooperators.

Accurate, timely and comparable groundwater level data is essential to understand the physical system, to calculate water balances, and to evaluate management options.

Without a strong, sound groundwater level monitoring program, the Department, local agencies and regional organizations will have difficultly fully embracing integrated regional water management planning.

@@ climate change, performance measures, and analytical tools for a myriad of programs.

Appendix 1. Description of Water Data Library

Water Data Library is a centralized data management system for groundwater levels, water quality, surface water data, and some climate data. Each of these disciplines has its own component or module within Water Data Library.

General Overview

All access to Water Data Library is done via your favorite web browser.

Water Data Library is supported by an Oracle version 8 database, and code for the web pages is written in a combination of ColdFusion version 5, Microsoft's ASP, javascript, and perl. In addition, some data (continuous data for groundwater levels, surface water, and water quality) is stored Hydstra. Hydstra is a proprietary application specifically developed to store, check and report on time-series data.

Development and testing of web pages is done on a separate system (and with a separate data base) from the production system. The production system is what the public, and staff in DWR use on a regular basis.

Groundwater Level Measurements

Groundwater level measurements are collected by DWR or one of its local cooperators. The data is then entered into the groundwater module of Water Data Library by District staff. Large batches of data may be entered with a batch process at Headquarters.

There are two types of groundwater level measurements: periodic and continuous. The periodic data is stored in the Oracle data base. Continuous data is stored in Hydstra. Each has its own data retrieval tools within the groundwater level module.

Periodic data for individual wells may be obtained from a map interface, showing the location of the well; by groundwater basin, or by Township, Range and Section. Bulk data may be obtained by part of a groundwater basin, the entire groundwater basin, or an entire county. (These last two methods are available only to DWR staff, not the general public.)

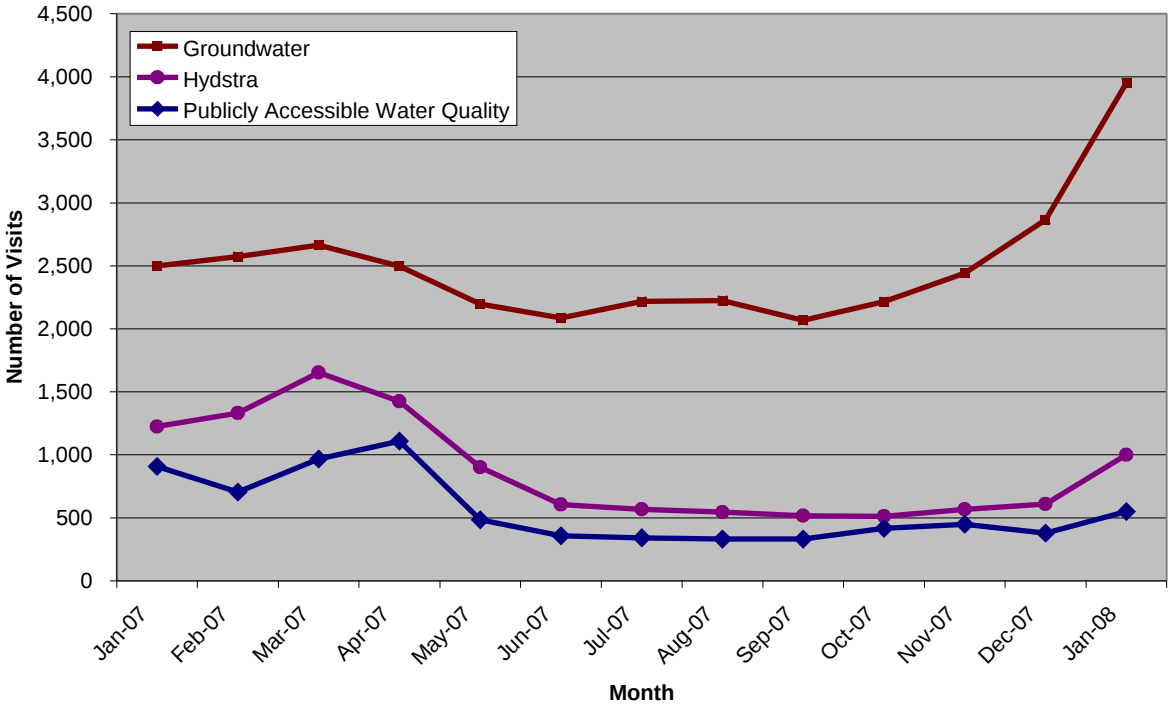
Water Data Library displays a hydrograph, the individual measurements plotted in the hydrograph, and specific information about the well. The user has a choice to down-load groundwater level measurements in Excel, comma separated values, and text formats.

Water Data Library has tools to disseminate periodic data to develop contours by basin, seasonal data by basin, and special projects.

Continuous data is organized differently, because it is stored in Hydstra. Reports from Hydstra are generated weekly, and made available on the publicly-accessible server. Data is available by site name or ID. The reports include hydrographs and comma separated values data.

Figure 5 presents the number of visits to Water Data Library between January 2007 and January 2008. The visits are divided into visits to groundwater pages, visits to Hydstra pages, and visits to water quality pages. In May 2007, we started to block spiders, so the number of visits fell off. The groundwater module is visited more than 2,000 times per month, with a generally increasing number of visits over time. (The slope is 1.51; but the R2 is only 0.129.)

Figure 5. Active Wells Each Year in Water Data Library



Tables 31 presents the number of individual reports requested for continuous data (from Hydstra) from Water Data Library. DWR has only monitored the number of reports since October 2007. There are three types sites with continuous data, groundwater surface water and tides. On average, there are 137 groundwater reports requested per month.

Table 31. Number of Visits by Month and Site Type

Year and Month	GW	SW	TD
2007 October	251	271	10
2007 November	81	193	47
2007 December	88	138	6
2008 January	130	665	111

There is difference between the reports requested in Table 31 and the visits in Figure 5. In one visit, a person may request multiple reports; or just look to see if something is available without requesting a report at all.

Appendix 2. Wells Monitored by DWR Districts

Year	Northern District	Central District	San Joaquin District	Southern District	Total
1900				1	1
1901				0	0
1902				1	1
1903				1	1
1904				1	1
1905				1	1
1906				3	3
1907				5	5
1908				3	3
1909				3	3
1910				4	4
1911				5	5
1912				4	4
1913				0	0
1914				0	0
1915				1	1
1916				2	2
1917				1	1
1918				0	0
1919				10	10
1920				4	4
1921	0	1	0	6	7
1922	1	0	0	92	93
1923	1	0	0	13	14
1924	0	0	2	66	68
1925	0	0	5	95	100
1926	1	0	7	47	55
1927	1	0	7	139	147
1928	1	2	7	116	126
1929	27	18	11	16	72
1930	29	33	7	56	125
1931	29	32	9	57	127
1932	27	32	11	48	118
1933	29	18	14	115	176
1934	28	19	14	102	163
1935	0	0	22	59	81
1936	30	19	31	31	111
1937	28	19	32	78	157
1938	1	0	40	78	119
1939	29	20	46	88	183
1940	24	3	44	48	119

Year	Northern District	Central District	San Joaquin District	Southern District	Total
1941	15	16	49	47	127
1942	7	4	61	35	107
1943	7	1	61	26	95
1944	7	0	85	110	202
1945	7	2	103	45	157
1946	10	2	112	49	173
1947	44	101	129	422	696
1948	99	143	176	423	841
1949	96	176	261	460	993
1950	108	169	330	393	1,000
1951	113	254	363	284	1,014
1952	124	387	416	286	1,213
1953	166	430	432	220	1,248
1954	131	289	465	159	1,044
1955	74	204	512	290	1,080
1956	86	388	530	879	1,883
1957	148	389	648	558	1,743
1958	254	198	1,901	675	3,028
1959	250	196	1,823	683	2,952
1960	206	256	2,065	676	3,203
1961	161	230	1,405		1,796
1962	141	244	1,727	829	2,941
1963	168	315	1,382	782	2,647
1964	156	405	1,106	871	2,538
1965	197	295	1,401	726	2,619
1966	200	349	1,305	680	2,534
1967	238	419	1,506	830	2,993
1968	244	502	1,736	781	3,263
1969	245	451	1,200	709	2,605
1970	238	427	1,028	651	2,344
1971	247	403	1,284	623	2,557
1972	260	641	1,972	619	3,492
1973	328	669	1,850	452	3,299
1974	326	657	2,019	527	3,529
1975	343	679	1,640	448	3,110
1976	373	554	1,219	483	2,629
1977	394	580	1,089	440	2,503
1978	439	562	714	435	2,150
1979	371	554	937	114	1,976
1980	439	568	922	76	2,005
1981	495	594	1,160	85	2,334
1982	485	585	1,196	80	2,346
1983	497	559	1,052	84	2,192
1984	507	557	1,046	82	2,192

Year	Northern District	Central District	San Joaquin District	Southern District	Total
1985	518	537	888	80	2,023
1986	543	525	611	66	1,745
1987	614	538	1,800	63	3,015
1988	637	531	1,998		3,166
1989	677	605	1,881		3,163
1990	782	646	1,913		3,341
1991	783	696	2,017		3,496
1992	851	692	2,013		3,556
1993	832	638	2,011		3,481
1994	860	661	1,969		3,490
1995	870	658	1,306		2,834
1996	886	609	1,339		2,834
1997	852	604	1,292		2,748
1998	838	565	1,452		2,855
1999	866	638	1,535		3,039
2000	895	647	1,407		2,949
2001	906	723	1,693		3,322
2002	940	735	1,618		3,293
2003	943	721	1,717		3,381
2004	941	704	1,765		3,410
2005	955	669	1,783	10	3,417
2006	996	644	1,684	20	3,344
2007	1,020	625	1,654	25	3,324

Appendix 3. Number of Wells in Groundwater Basins from Water Data Library

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Alexander Valley	12			
Alturas		21		
Amargosa Watershed				5
Ames Valley				101
Amos Valley				8
Anderson Valley	10			
Antelope Valley				2,309
Antelope Watershed				32
Anza Borrego Watershed				10
Arroyo Santa Rosa				46
Arroyo Seco Valley				18
Bessemer Watershed				1
Bicycle Valley				29
Big Lagoon Area		1		
Big Valley		20		
Borrego Valley				73
Bristol Valley				7
Bristol Watershed				44
Brite Valley			9	
Broadwell Valley				1
Broadwell Watershed				1
Brown Mountain Valley				1
Bunker Hill				289
Burns Valley		2		
Butte Valley		57		
Cadiz Valley				1
Calzona Valley				79
Carlsbad Watershed				11
Carpinteria Basin				219
Catheys Valley Hardrock Area			6	
Caves Canyon Valley				18
Central				121
Chemehuevis Watershed				2
Chemhuevi Valley				63

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Chilcoot Sub-bas of Sierra Vly		18		
Chino				26
Chuckwalla Valley				40
Chuckwalla Watershed				5
Clark Watershed				1
Clayton Valley	8			
Coachella Valley				59
Coahuila Valley				178
Collayomi Valley		14		
Colorado Watershed				42
Copper Mountain Valley				54
Coso Watershed				4
Coyote Lake Valley				27
Coyote Valley		9		
Coyote Watershed				1
Coyote Wells Valley				69
Cronise Valley				6
Cucamonga				1
Cuddeback Valley				32
Cuddeback Watershed				6
Cummings Valley			52	
Cuyama River				271
Dale Valley				6
Dale Watershed				1
Darwin Valley				2
Davis Valley				1
Deadman Valley				39
Death Valley				36
Denning Spring Valley				2
Desert Hot Springs				1
Dog Valley	2			
East Bay Plain	46			
East Salton Sea Basin				1
Eel River Valley		9		
El Mirage Valley				153
Emerson Watershed				2
Escondido Creek (Formerly 9-60)				3
Eureka Plain		4		
Fall River Valley		19		
Fenner Valley				31

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Fillmore				41
Foothill				118
Fort Bragg Terrace Area	8			
Fremont Valley				247
Fremont Watershed				3
Garcia River Valley Area	8			
Gilroy-Hollister Valley			28	
Goldstone Valley				6
Goleta Basin				405
Goose Lake Valley		12		
Gualala River Valley Area	1			
Half Moon Bay Terrace	8			
Harper Valley				445
Healdsburg Area	8			
High Valley		6		
Honey Lake		70		
Hoopa Valley		5		
Hungry Valley				2
Imperial Valley				61
Imperial Watershed				1
Indian Wells Valley				562
Indian Wells Watershed				9
Inns Valley			11	
Irwin				69
Ivanpah Valley				33
Ivanpah Watershed				41
Johnson Valley				52
Joshua Tree				60
Joshua Tree Watershed				22
Kelseyville Valley (Big Vly)		88		
Kelso Valley				6
Klamath River Valley		2		
Lake Almanor Valley		10		
Lake McClure Hardrock Area			3	
Lanfair Valley				19
Langford Well Lake				11
Las Posas Valley				4
Laytonville Valley		4		
Little Cuddy Valley				10
Little Lake Valley		8		

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Lockwood Valley				20
Long Valley		32		66
Lost Horse Valley				7
Lower Lake Valley		4		
Lower Mojave River Valley				1,098
Lower Russian River Valley	1			
Lucerne Valley				415
Lucerne Watershed				6
Mad River Valley		4		
Madeline Plains		3		
Martis Valley	16			
Mason Valley				3
Means Valley				4
Mesquite Valley				3
Middle Amargosa Valley				71
Middle Mojave River Valley				311
Mission Creek				12
Mission Valley				1
Mohawk Valley		2		
Mojave Watershed				63
Mono Valley				1
Montecito				153
Morongo Valley				1
Mound				15
Mugu Forebay				32
Napa Valley	143			
Needles Valley				184
Ocotillo Valley				4
Ogilby Valley				49
Ojai Valley				36
Orange County Coastal Plain				736
Orocopia Valley				2
Otay Watershed				155
Owens Valley				87
Owens Watershed				36
Oxnard				14
Oxnard Plain				343
Pahrump Valley				17
Pajaro Valley			19	
Palo Verde Mesa				462

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Palo Verde Valley				220
Panamint Valley				12
Panamint Watershed				15
Panoche Valley			48	
Penasquito Watershed				6
Pescadero Valley	5			
Petaluma Valley	30			
Pilot Knob Valley				6
Pinto Valley				2
Piru				8
Pittsburg Plain	7			
Piute Valley				3
Piute Watershed				14
Pleasant Valley				5
Potter Valley	4			
Poway Valley				5
Prairie Creek		1		
Quatal Canyon				5
Quien Sabe Point Valley				14
Ranchita Town Area				46
Redding		80		
Redwood Creek Valley		1		
Rialto-Colton				82
Rice Valley				14
Riggs Valley				1
Riverside-Arlington				20
Rose Valley				5
Round Valley		17		
Sacramento Valley (Butte Co.)		273		
Sacramento Valley (Capay Valley)	24			
Sacramento Valley (Colusa Co.)	9	135		
Sacramento Valley (Glenn Co.)		290		
Sacramento Valley (Placer County)	98			
Sacramento Valley (Sacramento County)	288			
Sacramento Valley (Solano County)	246			
Sacramento Valley (Sutter County)	187			
Sacramento Valley (Tehama Co.)		305		
Sacramento Valley (Yolo County)	512			
Sacramento Valley (Yuba County)	132			
Saline Valley				2

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Salt Wells Valley				4
San Antonio Creek Valley				254
San Antonio Watershed				17
San Diego River Valley				4
San Diego Watershed				3
San Dieguito Watershed				14
San Fernando Valley				2
San Gabriel Valley				4
San Gregorio Valley	2			
San Jacinto				209
San Jacinto Valley Watershed				10
San Joaquin Valley (Chowchilla Basin)			355	
San Joaquin Valley (Delta-Mendota Basin)			1,932	
San Joaquin Valley (East Contra Costa Co.)	3			
San Joaquin Valley (Eastern San Joaquin Co.)	620		125	
San Joaquin Valley (Kaweah Basin)			1,038	
San Joaquin Valley (Kern County)			3,068	1,700
San Joaquin Valley (Kings Basin)			1,945	
San Joaquin Valley (Madera Basin)			531	
San Joaquin Valley (Merced Basin)	1		780	
San Joaquin Valley (Modesto Basin)			475	
San Joaquin Valley (Pleasant Valley)			267	
San Joaquin Valley (Tracy Basin)	22		136	
San Joaquin Valley (Tulare Lake Basin)			580	1
San Joaquin Valley (Tule Basin)			937	
San Joaquin Valley (Turlock Basin)			686	
San Joaquin Valley (Westside Basin)			2,226	
San Juan Valley				1
San Juan Watershed				694
San Luis Rey Valley				495
San Luis Rey Watershed				1,178
San Mateo Valley				19
San Onofre Valley				10
San Pasqual Valley				26
San Timoteo				78
Sanel Valley	6			
Santa Ana River Watershed				18
Santa Barbara Basin				113
Santa Barbara Watershed				276

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Santa Clara-Calleguas Watershed				4
Santa Margarita Valley				3
Santa Margarita Watershed				40
Santa Maria				957
Santa Maria Cuyama Watershed				38
Santa Monica				2
Santa Paula				113
Santa Rosa Plain	77			
Santa Ynez River Valley				1,567
Santa Ynez Watershed				165
Scott River Valley		9		
Scott Valley		21		
Searles Valley				138
Searles Watershed				20
Secret Valley		2		
Shasta Valley		34		
Sierra Valley		149		
Silver Lake Valley				2
Simi Valley				15
Smith River Plain		7		
Soda Lake Valley				8
Sonoma Valley	20			
Soquel Valley			39	
Southern Sierra Watershed				4
Squaw Valley			36	
Suisun-Fairfield Valley	53			
Superior Valley				30
Superior Watershed				4
Surprise Spring				39
Surprise Valley		52		
Sweetwater Watershed				18
Table Mountain Hardrock Area			3	
Tahoe Valley	17			
Tehachapi Valley East				1
Tehachapi Valley West			65	
Temecula Valley				599
Temescal				2
Terwilliger Valley				23
Thousand Oaks				10
Three Rivers Area			21	

Groundwater Basin Name	Central District	Northern District	San Joaquin District	Southern District
Tia Juana Watershed				1
Tierra Rajada Valley				15
Tule Lk Subbasin of Klamath Rv		85		
Twentynine Palms Valley				71
Ukiah Valley	6			
Upper Johnson Valley				4
Upper Kingston Valley				6
Upper Lake Valley		24		
Upper Mojave River Valley				1,430
Upper Ventura River				33
Vallecito-Carrizo Valley				31
Vandeventer Flat				4
Ventura County Basins				6
Vidal Valley				13
Walker Basin Creek Valley			39	
Ward Valley				1
Warner Valley				61
Warren Valley				70
West Coast				74
Whitewater Wartershed				4
Willow Creek Valley		8		
Ygnacio Valley	8			
Yucaipa				84
Yuma Valley				363
Yuma Watershed				3
Total Number of Basins	37	43	29	196

Appendix 4. Actions to Coordinate with Other Plans

Groundwater Level Monitoring Objective 5 Action ##
Standardized Forms and Codes for Reporting Groundwater Level Measurements

I believe this is the same as data exchange for cooperators. I have combined the two actions.

Well Completion Report Objective 1 Action ##
Work With Well Completion Report To Develop A Uniform Geologic Nomenclature Within DWR.

Move to Well Completion Report Strategic Plan

Well completion reports have a section to describe the geology of the well. Understanding the geology is important when evaluating what aquifer a well is monitoring within a groundwater basin, and hydrologic interactions of water around the well. A standard geologic nomenclature for wells would make this easier.

There are many geologic classification systems to choose from. While a standard geologic nomenclature for well completion reports would not be reasonable (each driller has their own way of doing things, and would be very resistant to change), a standard for DWR is.

The nomenclature would include names of formations, specific yield, and unconsolidated material classifications

Appendix 5. Methods and Equipment Used to Collect Groundwater Level Measurements

DPLA collects two types of groundwater level measurements:

1. Periodic measurements.
2. Continuous measurements

Periodic Measurements

Table 32 presents the number of wells periodically monitored by each district.

Table 32. Number of Wells Monitored Periodically

	Northern District	Central District	San Joaquin District	Southern District
Monthly		203		
Quarterly				25
Semi-Annual (twice-a-year)		528	485	140
Sporadically			1219	12
Total		731		177

Wells from SD are for Watermaster program. Does ND include their watermaster wells in this? In WDL?

Table 33 presents the type of equipment used by each district.

Table 33. Equipment Used to Measure Depth to Water

Manufacturer	Accuracy	Northern District	Central District	San Joaquin District	Southern District
Solinst Model 101 (electronic sounder?)	0.01 ft		X		X
Solinst Model DR-772			X		X
Slope Indicator (electronic sounder?)			X		
In-Situ (electronic sounder?)			X		
Steel Surveyor's Tape			X	X	X
SA Electronics, Model 10A (Acoustic sounder)				X	

Methods

If an electronic sounder cannot be safely used on a well, or oil is present, depth to water is measured with a tape.

Groundwater levels are measured relative to a reference point on the top of the well casing, vault, or relative to ground surface. Measurements are repeated until a consistent reading is observed.

Groundwater level measurements are recorded in field notebooks. Questionable measurements are qualified as such in the field notebook.

Data from the field notebooks are entered into Water Data Library. Once in Water Data Library, the data is available to the public.

Continuous Measurements

Table 34 presents the number of wells periodically monitored by each district.

Table 34. Number of Wells Monitored Continuously

	Northern District	Central District	San Joaquin District	Southern District
In Hydstra	199	114		
Common to WDL and Hydstra	186	43		

Table 35 presents the type of equipment used by each district.

Table 35. Equipment Used to Measure Depth to Water

	Accuracy?	Northern District	Central District	San Joaquin District	Southern District
In-Situ MiniTROLLS Professional	0.25 ft		X		X
In-Situ Multi-Parameter TROLL 9000E, model LTS	0.25 ft		X		X
INW	0.25 ft		X		

Table 36 presents the type of data loggers or computers used by each District.

Table 36. Equipment Used to Store Continuous Groundwater Level Measurements

	Northern District	Central District	San Joaquin District	Southern District
In-Situ Rugged Readers		X		
INW palmtops		X		

Methods

There are two types of equipment to continuously measure groundwater levels, vented and un-vented.

Vented models are typically used in wells with above ground surface completions where there is minimal to no flooding potential, no historic artesian flowing conditions, and no significant moisture problems. The vented models are internally corrected for barometric pressure fluctuations which allows for direct comparison of sounder measurements versus the last data logger reading in the field.

Non-vented models are typically used in wells with flush-mount vaults, recorded or suspected artesian flowing conditions, and high moisture conditions inside vaults. The non-vented models measure total pressure (including hydrostatic + barometric). These measurements must be processed in the field or office to remove the barometric pressure effects and are then converted to water levels in depth below reference point in order to compare to sounder measurements to check for data drifting.

Data loggers are typically set to collect data on a 1-2 hour interval. Data loggers in wells near stream gages are set to collect data on 15-minute intervals to be consistent with DWR surface water data collection protocols. All data logger clocks are set to record time relative to Pacific Standard Time consistent with DWR surface water data collection protocols.

During a visit to a well, the time, weather conditions, battery voltage and percent remaining battery life, memory level (percent used), current water level, current water temperature, and a unique visit number, are recorded in the field notebook.

The groundwater level is also measured, following the procedures described for periodically monitoring.

If the drift for water level measurement during a set of observations is equal to or greater than the predefined tolerance, then the rest of the observations are discarded, the reference level reset, and the data collection is restarted.

Data from the data loggers are entered into Hydstra. Reports from Hydstra are automatically generated each week, and put on Water Data Library. Once in Water Data Library, the data is available to the public.

Location

Table 37 presents the type of equipment used by each district. The DGSI and Solinst are preferred methods to measure depth to water. These are accurate to 0.01 feet. If the well is inaccessible, or oil is present, depth to water is measured with a steel surveyor's tape.

Table 37. Equipment Used to Locate a Well

	Datum	Northern District	Central District	San Joaquin District	Southern District
Garmin eTrex GPS	NAD83		X		
Sokkia Axis 3					X

Appendix 6. Proposed Meta-Data Standards for Groundwater Levels

Name of Data Set
Version
Creator
Last Updated

Contact Information
- Responsible contact name
- Responsible organization name
- Responsible contact telephone number
- Responsible contact electronic mail address

Description
- Purpose for data set
- History of versions
- Anomalies in the data
- General comments

Data Dictionary
- For each field
  - Field name
  - Data type
  - Size
- Description of codes or ID

Statistics
- Number of records
- Size of data set (bytes, KB, MB, GB or TB)

Access Permission
- Who can access the data?
- Messages if permission denied